OCR
Oxford Cambridge and RSA

AS Level Physics A

H156/02 Depth in physics

Thursday 8 June 2017 – Afternoon

Time allowed: 1 hour 30 minutes

6891524979

You must have:
- the Data, Formulae and Relationships Booklet (sent with general stationery)

You may use:
- a scientific or graphical calculator
- a ruler (cm/mm)

H 1 5 6 0 2

First name										
Last name										
Centre number						Candidate number				

INSTRUCTIONS
- Use black ink. HB pencil may be used for graphs and diagrams.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

INFORMATION
- The total mark for this paper is **70**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended responses will be assessed in questions marked with an asterisk (*****).
- This document consists of **24** pages.

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Answer **all** the questions.

1 **(a)** Define what is meant by the *stopping distance* of a vehicle.

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..... **[1]**

(b) Fig. 1.1 shows a train of mass 1.9×10^5 kg travelling at 61 km h^{-1} along a level track.

Fig. 1.1

(i) Show that the train is travelling at about 17 m s^{-1}.

[1]

(ii) The brakes of the train are applied and the train is brought to rest in a distance of 310 m. Calculate

1. the initial kinetic energy E_k of the train

E_k = ... J **[2]**

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2. the average deceleration a of the train

a = ... ms^{-2} **[3]**

3. the average braking force F on the train.

F = ... N **[2]**

(iii) Fig. 1.2 shows a similar train travelling at $61\,km\,h^{-1}$ up an incline.

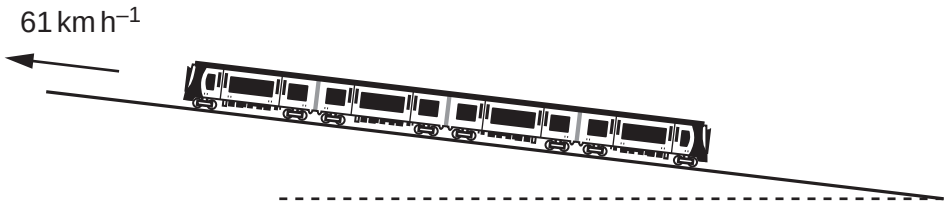

Fig. 1.2

The brakes of the train are applied with the **same** average braking force.
State and explain how the distance that the train travels, from when the brakes are applied until the train stops, compares with when the train is travelling on level track.

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..... **[2]**

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2 Fig. 2.1 shows an experiment in the laboratory to investigate the extension of two identical springs connected end to end. A student initially measures the length *L* of the two-spring combination without a load attached.

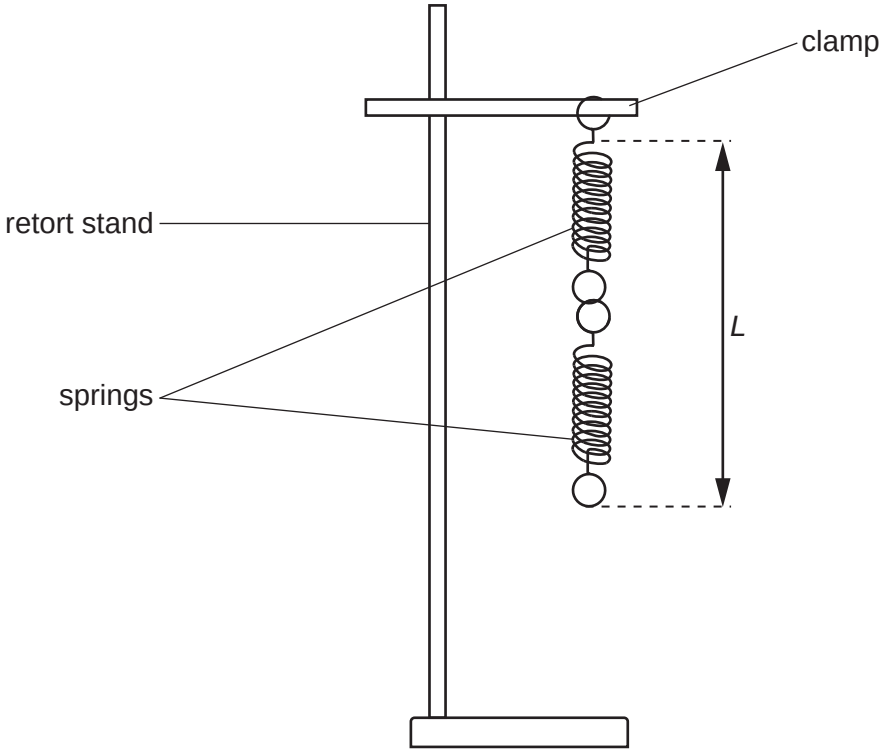

Fig. 2.1

Question 2 continues on page 6

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The student adds mass *m* to the lower spring and measures the new length *L* of the two-spring combination.

The student determines the weight *F* of the mass added to the spring.

The student's results are shown in Fig. 2.2.

m **/ g**	***F*** **/ N**	***L*** **/ cm**	
0	0	12.0	
50	0.49	13.0	
100	0.98	13.8	
150	1.47	14.8	2.8
200	1.96	15.6	3.6
250	2.45	16.6	4.6

Fig. 2.2

(a) Complete the table shown in Fig. 2.2 by calculating and recording values of the extension *e* / cm of the spring combination. **[1]**

(b) On Fig. 2.3 plot a graph of *e* / cm (*y*-axis) against *F* / N (*x*-axis). Draw the straight line of best fit. **[4]**

(c) Determine the gradient of the straight line of best fit.

gradient = ... **[1]**

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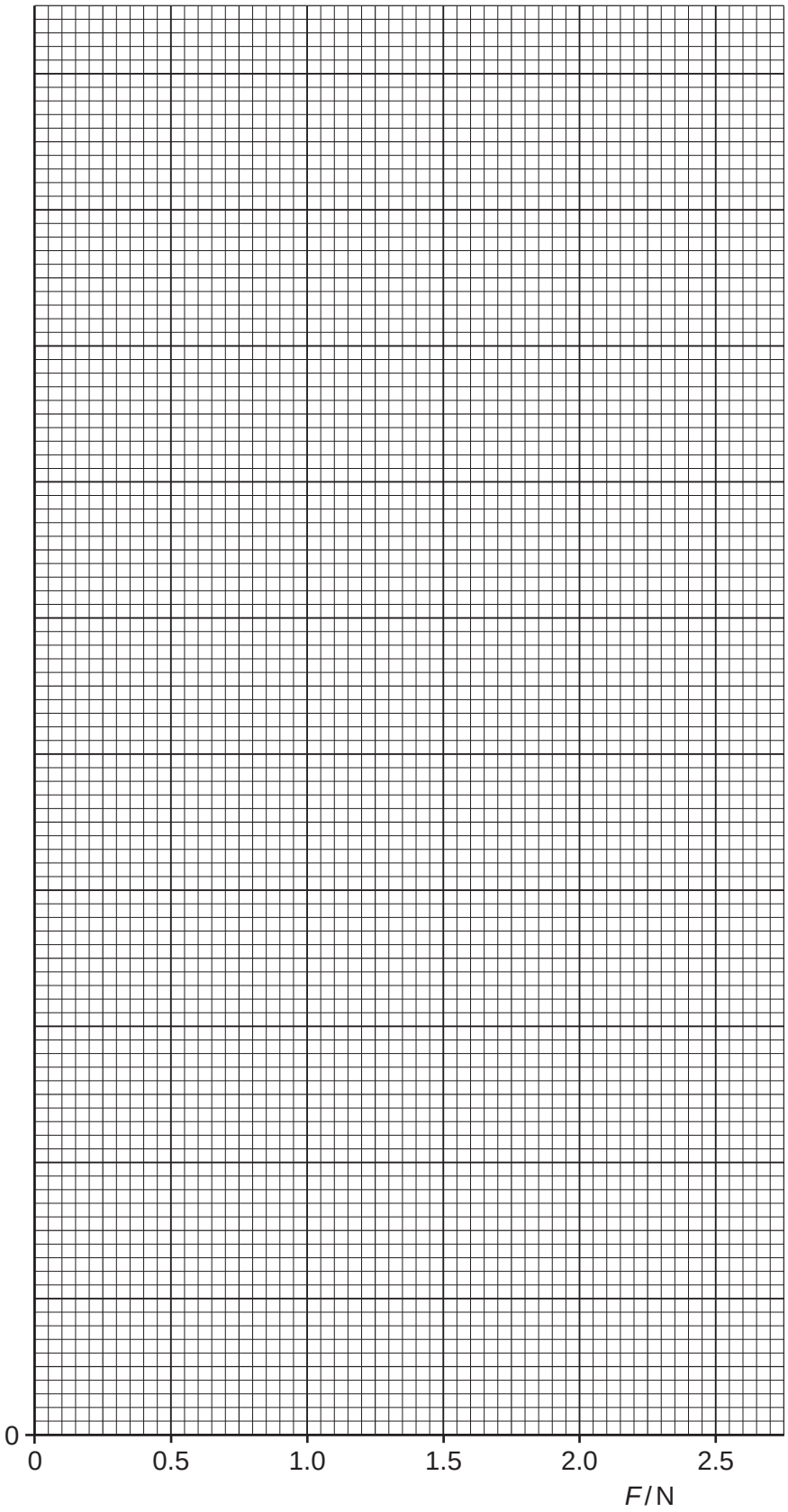

Fig. 2.3

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(d) Use your answer to **(c)** to determine the experimental value for the force constant k_2 of the two-spring combination. Include an appropriate unit.

k_2 = ... **[2]**

(e) State and explain whether your graph shows that the spring combination obeys Hooke's law.

.....

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.....

..... **[2]**

(f) The experiment is repeated with a third identical spring added to the bottom of the two springs. The force constant of this new three-spring combination is k_3.

Determine the ratio

$$\frac{k_3}{k_2}.$$

$\frac{k_3}{k_2}$ = ... **[2]**

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3 **(a)** A solid wooden sphere of density 650 kg m^{-3} has a diameter of 2.8 cm.

(i) Describe and explain how the student can measure precisely the diameter of the sphere.

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..... **[2]**

(ii) Show that the mass of the sphere is 0.0075 kg.

[2]

(iii) The sphere is pushed below the surface of water as shown in Fig. 3.

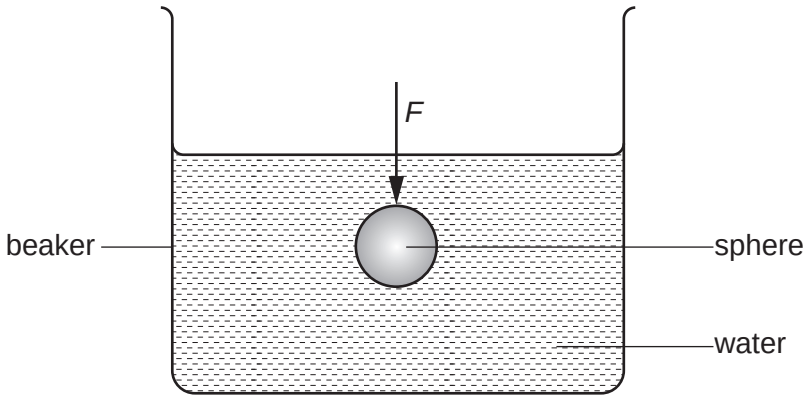

Fig. 3

Determine the force *F* that needs to be applied to the sphere to keep the wooden sphere stationary in this position.
density of water = 1000 kg m^{-3}

F = ... N **[2]**

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(b)* A student wishes to investigate how the terminal velocity v of a metal sphere varies with the radius r of the sphere as it travels through a liquid.
It is suggested that

$$v = Kr^2$$

where K is a constant.

Describe with the aid of a suitable diagram how an experiment can be safely conducted, and how the data can be analysed to determine K.

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4 Some houses are heated by “night storage heaters” which use cheap electricity between the hours of midnight and 7.00 am.

Fig. 4.1 shows a circuit diagram of three identical 230 V, 3.5 kW storage heaters connected to a 230 V mains power supply of negligible internal resistance.

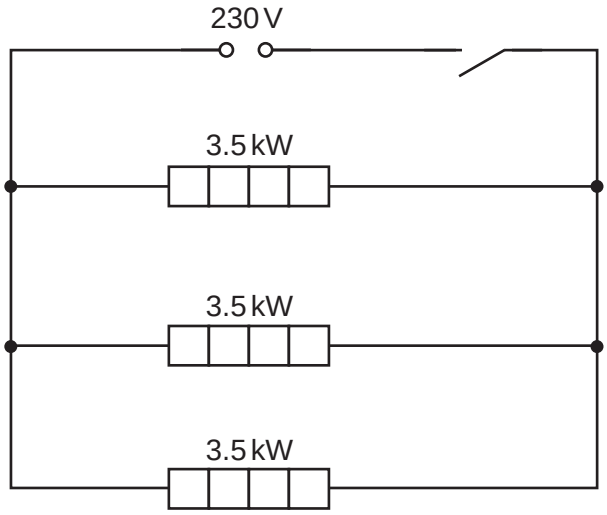

Fig. 4.1

(a) (i) Show that the resistance of each heating element is about 15 Ω when the heater is operating at 230 V.

[1]

(ii) The heating element is constructed from a metallic wire of resistivity $1.6 \times 10^{-6}\,\Omega\,\text{m}$.
The radius of the wire is 0.55 mm.
Determine the length L of the metallic wire in one heating element.

L = ... m **[3]**

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(iii) State and explain whether the heater obeys Ohm's law.

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..... **[2]**

(b) The cost of 1 kW h of energy is 7.6 pence.

Calculate the cost of using the three storage heaters between midnight and 7.00 am every night for one week.

cost = £ ..... **[2]**

Question 4 continues on page 14

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(c) A student monitors the temperature in a room by using a potential divider circuit containing a negative temperature coefficient (NTC) thermistor. The student sets up the circuit shown in Fig. 4.2.

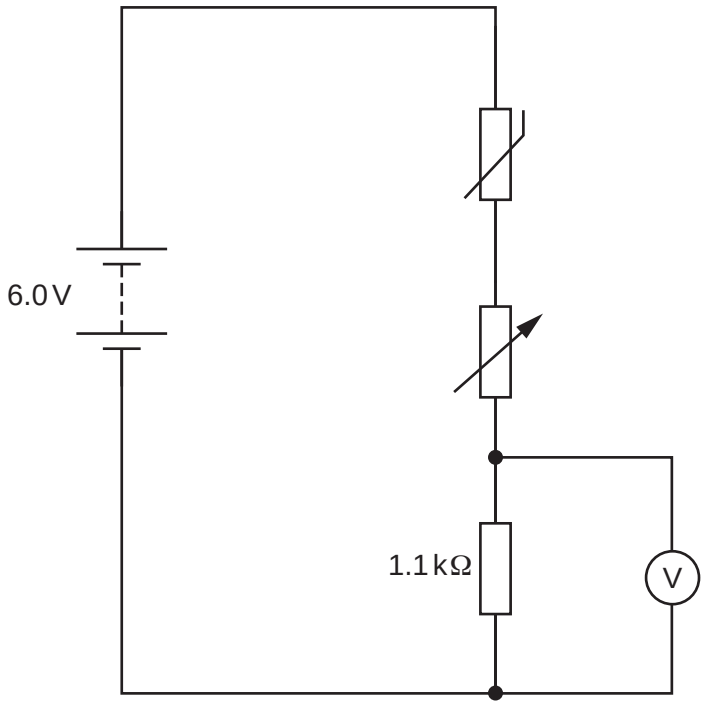

Fig. 4.2

The battery has an e.m.f. of 6.0 V and negligible internal resistance.

(i) When the temperature of the thermistor is 12 °C the thermistor has a resistance of 6.8 kΩ. The resistance of the variable resistor is set to a value of 1.4 kΩ.
Calculate the reading *V* on the voltmeter.

V = ... V **[2]**

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(ii) Explain how the reading on the voltmeter will change when the temperature of the thermistor increases.

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..... **[4]**

Question 5 begins on page 16

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5 This question is about a laser pen.

(a) Define the terms *phase difference* and *coherence*.

phase difference .....

.....

coherence .....

..... **[2]**

(b) Green light from the laser pen passes through a pair of narrow slits $\mathbf{S_1}$ and $\mathbf{S_2}$ as shown in Fig. 5.1.

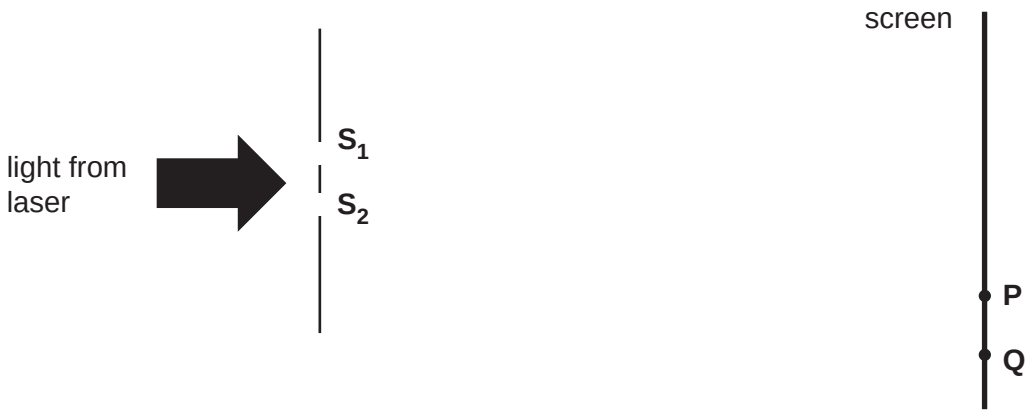

Fig. 5.1

A pattern is produced on a screen consisting of regularly spaced bright and dark lines as shown in Fig. 5.2.

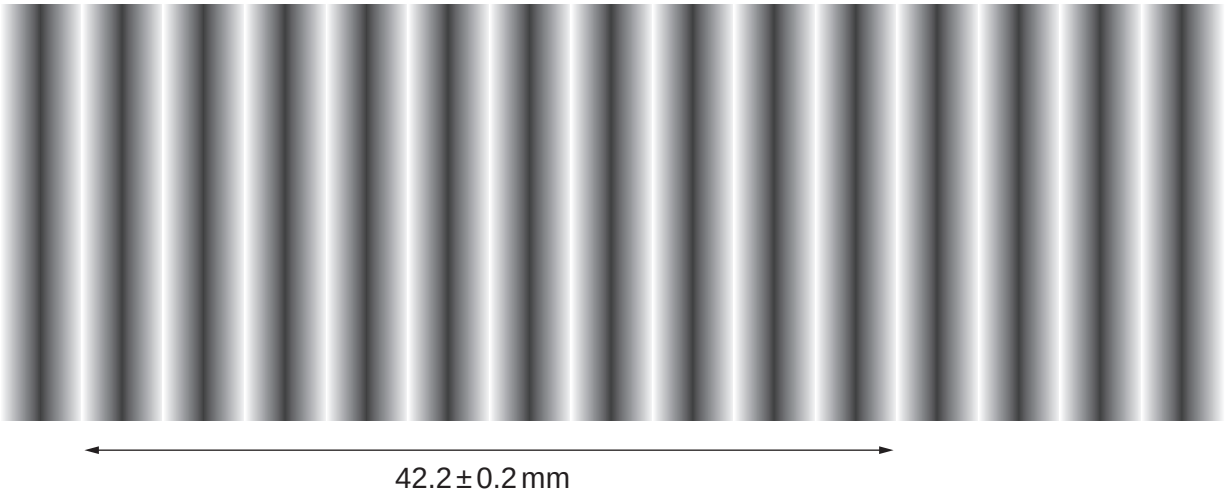

Fig. 5.2

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(i) Fig. 5.1 shows two points, **P** and **Q**, on the screen. Explain in terms of path difference why point **P** is a bright line and point **Q** is a dark line.

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..... **[2]**

(ii) The screen is at a distance of 4.50 ± 0.02 m from the slits and the slit separation is 0.56 ± 0.02 mm.

1. Use Fig. 5.2 to determine the wavelength λ of the light.

$\lambda =$ ..... m **[3]**

2. Determine the percentage uncertainty in λ.

percentage uncertainty = ... % **[2]**

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(c) The power of the green light from the laser pen is 50.0 mW. It is now used in a demonstration of the photoelectric effect.

(i) Calculate the number of photons n that the laser emits per second.

n = ... **[2]**

(ii) The green light falls on a negatively charged metal plate with a work function of 2.6 eV. Explain whether photoelectrons will be emitted.

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..... **[2]**

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Question 6 begins on page 20

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6 **(a)** Describe how a stationary wave is different from a progressive wave.

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..... **[2]**

(b)* A student is investigating stationary waves in a hollow tube. The tube is open at one end and closed at the other end. The student connects a signal generator to a loudspeaker which is placed just above the tube as shown in Fig. 6.

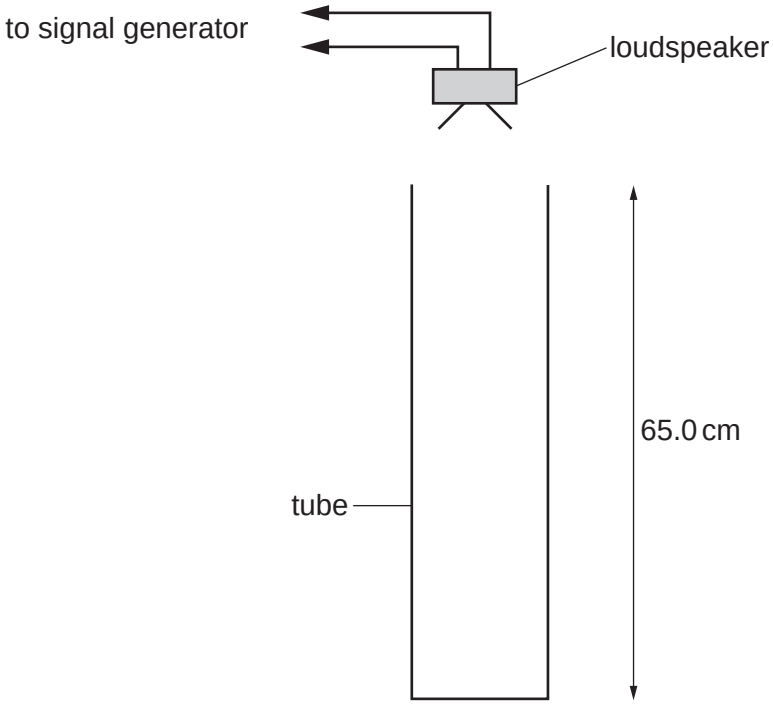

Fig. 6

The length of the tube is 65.0 cm.

As the frequency of the signal generator is slowly increased from 0 Hz the student observes sound that varies in loudness. The loudest sound occurs at frequencies 130 Hz, 390 Hz and 650 Hz.

The experiment is then repeated with a hollow tube of the **same** length but open at both ends. The loudest sound now occurs at frequencies 260 Hz, 520 Hz and 780 Hz.

Using your knowledge and understanding of stationary waves explain these observations. Include in your answer how you could determine an experimental value for the speed of sound in air.

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ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

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